MI-94312B
GEK-61380B

INSPECTION AND SERVICE

TURBOCHARGERS

(GENERAL ELECTRIC)

MODELS 7S1616A1, 7S1616B1, 7S1616B2 AND 7S1616B3*

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ALLIED PUBLICATION
Repair and Overhaul Instruction GEK-61381

SCOPE

This instruction covers maintenance procedures necessary to effect running-repair operations only. When extensive, back-shop repairs are required, refer to publication GEK-61381.

DESCRIPTION

GENERAL

The General Electric turbocharger is a centrifugal air compressor (blower) driven by engine exhaust gases prior to their discharge to the atmosphere.

The compressed air, produced by the turbocharger, serves two useful purposes:

1. During the latter part of the exhaust stroke and the early part of the intake stroke there is an interval in the cycle, called the valve overlap, when both inlet and exhaust valves are open. During the overlap period, compressed air, directed into the combustion chamber, expells the spent exhaust gases and lowers the temperature of piston and cylinder parts.
2. Compressed combustion air, compared with combustion air if it were naturally aspirated, contains more oxygen per volume which allows the efficient burning of more fuel. This, in effect, raises the efficiency of the engine, since a given engine mass now produces more power.

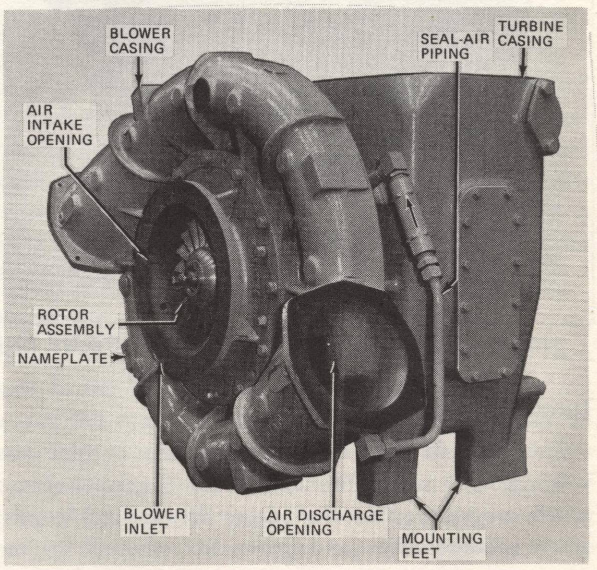

FIG. 1. MODEL 7S1616A1 TURBO, COMPRESSOR END.

FIG. 1, E-24450

MECHANICAL CONSTRUCTION

The turbocharger has the following main sub-assemblies:

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*Revisions are indicated by marginal bars.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

GENERAL ELECTRIC

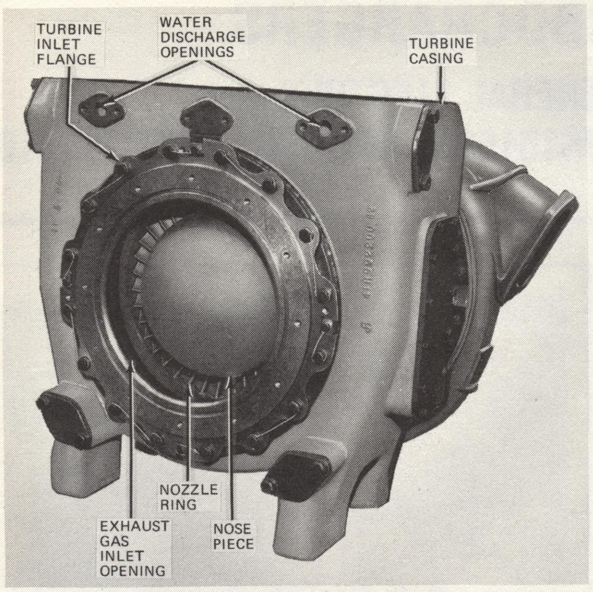
TURBINE INLET FLANGE
WATER DISCHARGE OPENINGS
TURBINE CASING
NOZZLE RING
EXHAUST GAS INLET OPENING
NOSE PIECE

FIG. 2. MODEL 7S1616A1 TURBO, TURBINE END.

Turbine Casing Assembly

This assembly is composed of the turbine casing, bearings, and seals. The casing has four mounting feet which are secured to the engine forward-end cover. All other sub-assemblies and parts are secured to, or are mounted in, the turbine casing.

Rotor Assembly

This assembly is composed of the turbine disk assembly, compressor wheel assembly, shaft, stud, thrust collar and cap. The rotor assembly rotates in the bearings of the turbine casing assembly.

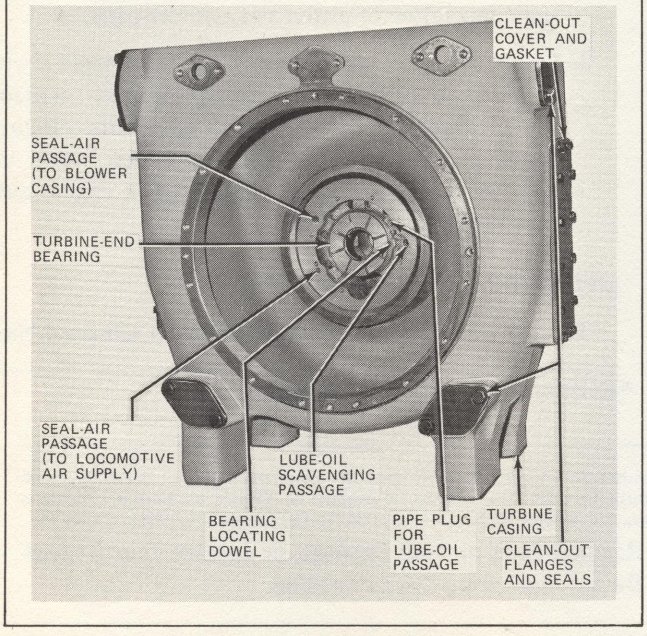
CLEAN-OUT COVER AND GASKET
SEAL-AIR PASSAGE (TO BLOWER CASING)
TURBINE-END BEARING
SEAL-AIR PASSAGE (TO LOCOMOTIVE AIR SUPPLY)
LUBE-OIL SCAVENGING PASSAGE
BEARING LOCATING DOWEL
PIPE PLUG FOR LUBE-OIL PASSAGE
TURBINE CASING
CLEAN-OUT FLANGES AND SEALS

FIG. 3. TURBINE CASING ASSEMBLY, TURBINE END.

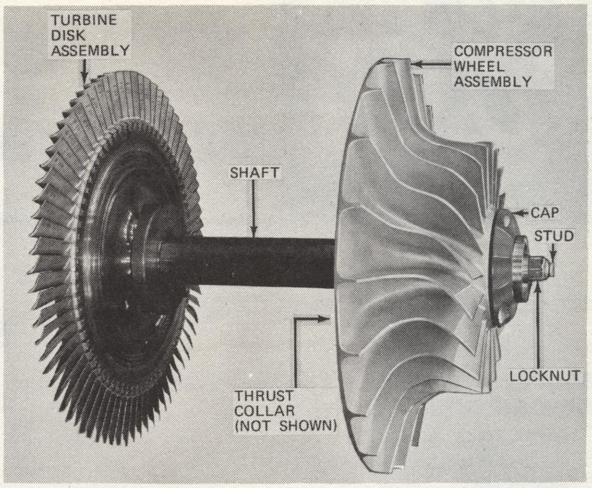
TURBINE DISK ASSEMBLY
COMPRESSOR WHEEL ASSEMBLY
SHAFT
CAP
STUD
THRUST COLLAR (NOT SHOWN)
LOCKNUT

FIG. 4. ROTOR ASSEMBLY.

Turbine Inlet Assembly

This assembly is composed of the turbine inlet flange, nozzle ring, nozzle-ring retainer, turbine shroud, and nose piece. This assembly is mounted in the turbine end of the turbine casing and is, in turn, connected to the engine exhaust manifold.

Blower Casing Assembly

This assembly consists of the blower casing, the blower inlet, and the diffuser. This assembly is secured to the

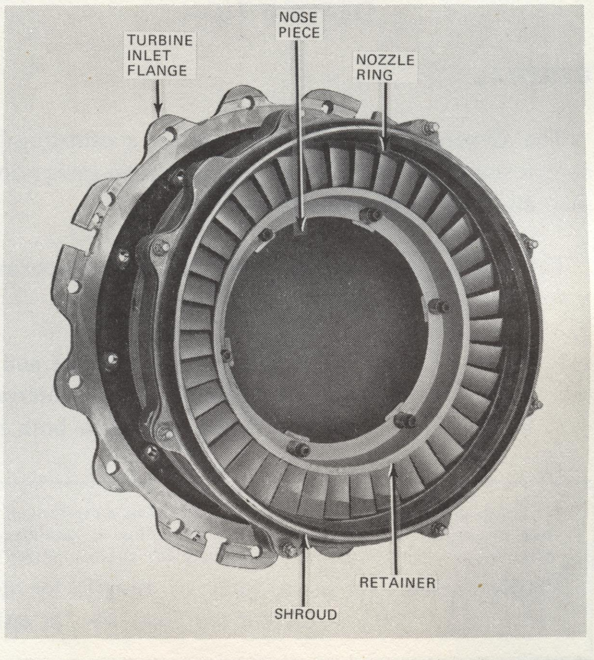
TURBINE INLET FLANGE
NOSE PIECE
NOZZLE RING
RETAINER
SHROUD

FIG. 5. TURBINE INLET ASSEMBLY.

FIG. 2, E-24451
FIG. 3, E-24452
FIG. 4, E-24453
FIG. 5, E-24454

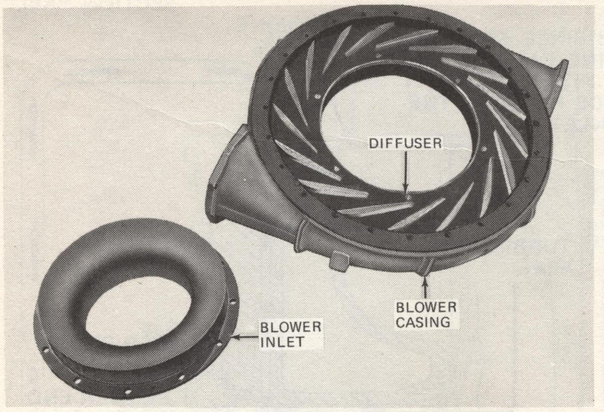

FIG. 6. BLOWER CASING ASSEMBLY.

FIG. 6, E-24455

compressor end of the turbine casing. The inlet portion is connected to the supply of filtered engine combustion air; the two outlets are joined by discharge elbows to the intercoolers and then to the air-intake manifold.

SYSTEMS

The turbocharger is connected to, and is a part of, the following locomotive systems:

Lubricating Oil

The lubricating oil is taken from the engine main-header supply at the front of the forward-end cover. The oil first passes thru an orifice in the flange connected to the cover which controls the rate of flow to the turbocharger. Oil flows thru a pipe and is delivered to a connection point in the top portion of the turbine casing. A radially-drilled hole, which intersects with other holes, conducts oil to the two bearings. After lubricating and cooling the bearing surfaces, oil then flows by gravity thru cored passages in the turbine casing and a drainage pipe down to the forward-end cover.

A supplemental system employs a suction pump to draw lube-oil leakage and seal air from behind the turbine-end seal. This mixture is pulled into the suction pump where it combines with header-pressure oil (which created the suction) and flows thru a discharge pipe down to the forward-end cover. See Fig. 7.

Exhaust Gas

These gases are conducted from each cylinder to the turbine end of the turbocharger by the exhaust manifold. The exhaust gases are first guided thru a nozzle ring whose blades direct the gases toward the turbine buckets (in the rotor assembly) to achieve optimum utilization of the energy contained in the hot exhaust gases. After causing turbine rotation, by impingement on, and expansion thru, the turbine-bucket blades, the spent exhaust gases enter the turbine casing, then pass thru the exhaust stack to the atmosphere.

Engine Air

Engine air is drawn from outside the locomotive thru a series of screens, inertial cleaners, and filters by the turbocharger compressor and engine. The compressor wheel discharges air at high velocity to the diffuser, which reduces the velocity and increases the pressure before delivering it to the blower casing which, in turn, directs the pressurized air to each of the two blower-casing outlets. Due to heat generated during compression, the discharged, pressurized air first must be cooled down by passing it thru the intercoolers, to further increase its density, before it is delivered thru the air-intake manifold to each cylinder for combustion and cooling purposes.

Cooling Water

Cooling water is discharged by the water pump thru passages in the forward-end cover to two holes in the top surface of this cover. These cover holes align with holes in the two rear mounting feet of the turbocharger to pass water to internal, cored passages in the turbine casing. After lowering the temperature of the turbine casing, water is discharged thru two holes in the top, rear portion of the turbine casing and thru one hole in the top, front portion of the turbine casing into a header, then returned to the locomotive cooling water system.

Seal Air

In addition to the above four systems, the turbocharger has another air system totally within itself. This is known as the seal-air system and involves taking some of the pressurized air produced by the compressor wheel and delivering it thru a series of external tubes, internally-drilled holes, and passages to the outboard side of both seals. Pressure air, thus applied, minimizes the loss of lubricating oil thru the seals.

Supplementing this seal-air system is a second system, beneficial at low engine (and turbo) speeds. This system employs locomotive pressure air at 130 to 140 psi, passed thru an orifice fitting to reduce the pressure and volume of flow and delivered thru drilled passages in the turbine casing to the outboard side of the turbine-end seals. See Fig. 8.

Sealing air performs two additional functions at the turbine end of the system; it provides some cooling of the turbine disk assembly, and it produces a force on the face of the turbine disk to partially counter-balance the force produced both by the engine exhaust on the other side of the disk, and by the thrust produced in the blades, thereby reducing the loading on the turbine-end thrust bearing.

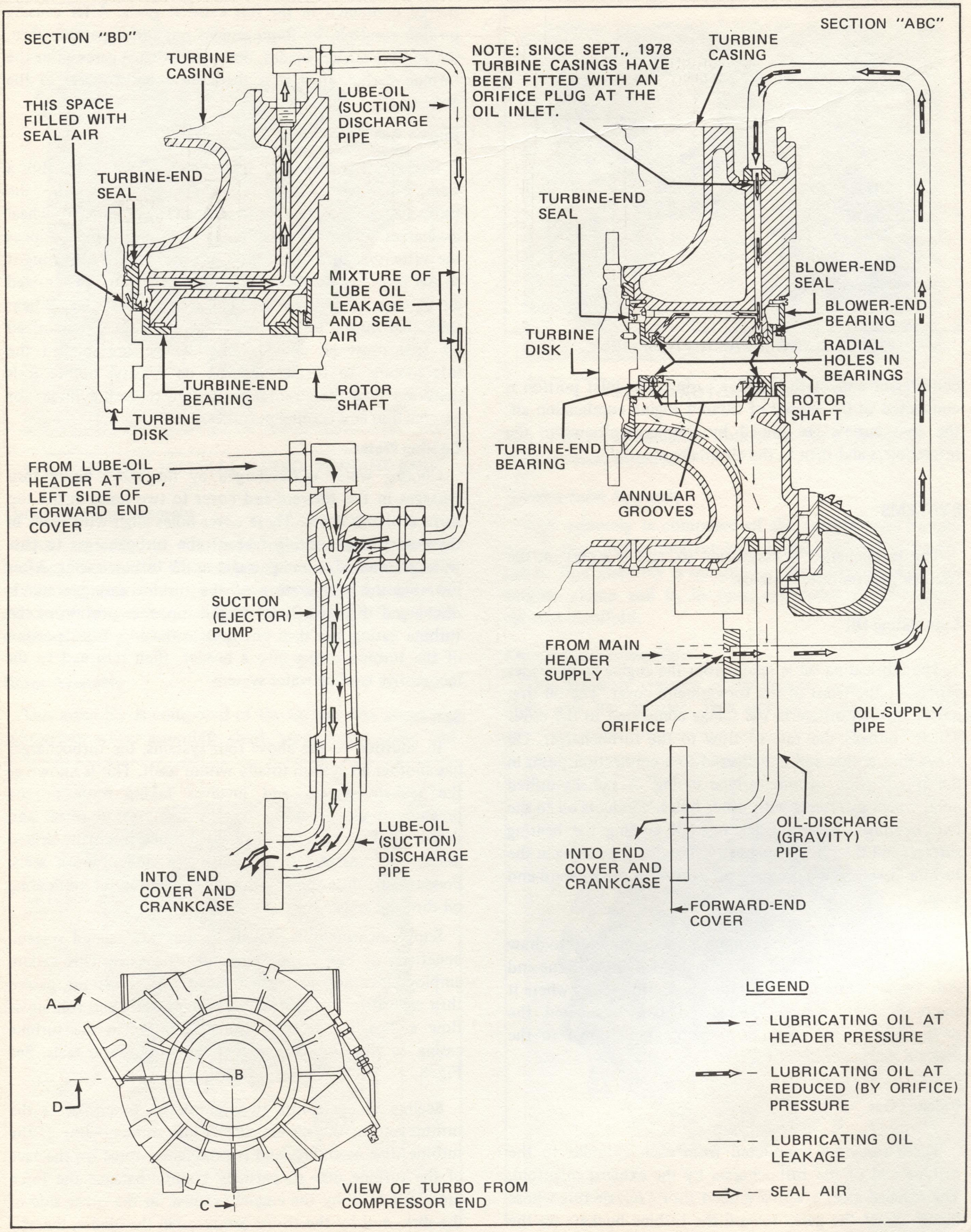
SECTION "BD"
TURBINE CASING
THIS SPACE FILLED WITH SEAL AIR
TURBINE-END SEAL
LUBE-OIL (SUCTION) DISCHARGE PIPE
MIXTURE OF LUBE OIL LEAKAGE AND SEAL AIR
TURBINE-END BEARING
ROTOR SHAFT
TURBINE DISK
FROM LUBE-OIL HEADER AT TOP, LEFT SIDE OF FORWARD END COVER
SUCTION (EJECTOR) PUMP
LUBE-OIL (SUCTION) DISCHARGE PIPE
INTO END COVER AND CRANKCASE
NOTE: SINCE SEPT., 1978 TURBINE CASINGS HAVE BEEN FITTED WITH AN ORIFICE PLUG AT THE OIL INLET.
SECTION "ABC"
TURBINE CASING
TURBINE-END SEAL
BLOWER-END SEAL
BLOWER-END BEARING
TURBINE DISK
RADIAL HOLES IN BEARINGS
ROTOR SHAFT
TURBINE-END BEARING
ANNULAR GROOVES
FROM MAIN HEADER SUPPLY
ORIFICE
OIL-SUPPLY PIPE
OIL-DISCHARGE (GRAVITY) PIPE
INTO END COVER AND CRANKCASE
FORWARD-END COVER
A
B
D
C
VIEW OF TURBO FROM COMPRESSOR END
LEGEND
→ – LUBRICATING OIL AT HEADER PRESSURE
➡ – LUBRICATING OIL AT REDUCED (BY ORIFICE) PRESSURE
— – LUBRICATING OIL LEAKAGE
⇨ – SEAL AIR
FIG. 7, E-24456A

FIG. 7. LUBRICATING-OIL FLOW.

FIG. 8, E-24457

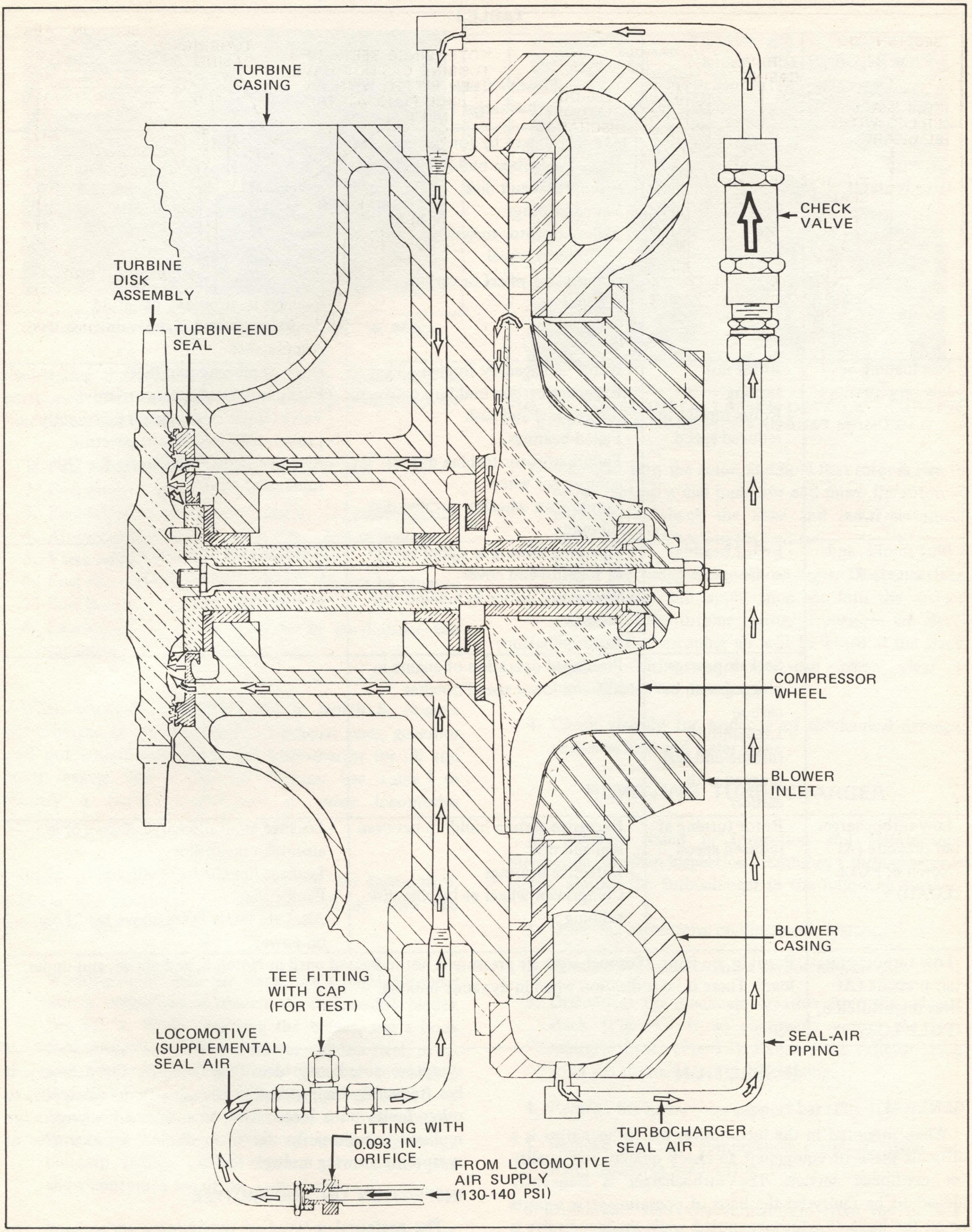
TURBINE CASING
TURBINE DISK ASSEMBLY
TURBINE-END SEAL
CHECK VALVE
COMPRESSOR WHEEL
BLOWER INLET
BLOWER CASING
SEAL-AIR PIPING
TEE FITTING WITH CAP (FOR TEST)
LOCOMOTIVE (SUPPLEMENTAL) SEAL AIR
FITTING WITH 0.093 IN. ORIFICE
FROM LOCOMOTIVE AIR SUPPLY (130-140 PSI)
TURBOCHARGER SEAL AIR

FIG. 8. SEAL-AIR ARRANGEMENT.

TABLE I

Crew Report Or Symptom	Actual Turbocharger Fault	Possible Cause Of Turbocharger Fault	Other Possible Locomotive Faults
Black smoke out stack (steady-state)	- Rotor not turning - Rotor turning at reduced speed	- Rotor damaged by foreign object - Excessive carbon build-up between turbine seal and disk - Failed bearings - Failure of rotor turbine disk or compressor wheel - Compressor wheel or turbine disk rubbing	- Injection pumps not properly timed - Faulty fuel injection pumps and/or nozzles - Excessive carbon build-up in air intake ports - Dirty intercoolers - Plugged engine air filters - Leakage in air-intake manifold - Faulty excitation circuit adjustments or components
Not loading or low on power	- Rotor not turning - Rotor turning at reduced speed	- Rotor damaged by foreign object - Excessive carbon build-up between turbine seal and disk - Failed bearings - Failure of rotor turbine disk or compressor wheel - Compressor wheel or turbine disk rubbing	- Dirty or plugged fuel filter - Fuel pump racks set incorrectly - Valve tappet clearance set incorrectly - Leak in manifold line to governor - Also, see faults listed above for "Black smoke out stack"
Blue smoke, and oil, out stack	- Failed bearings and/or seals	- Pipe plug missing in upper cavity of forward-end cover - Wrong size orifice in lube-oil supply pipe - Rotor unbalance	- Worn or broken piston rings - Cracked piston (crown) - Scored liner
	- Seal air passage plugged with carbon - Labyrinth in turbine-end seal plugged with carbon	- Prolonged operation of engine in idle and lower speed notches	
Low turbocharger air pressure (At Notch 8, FULL LOAD)	- Rotor turning at reduced speed	- Excessive carbon build-up between seal and disk - Defective bearings - Compressor wheel or turbine disk rubbing	- Leakage at air discharge elbows or in air-intake manifolds - Leakage in exhaust manifold - Faulty gage - Also, see faults listed above for "Low on power"
Low turbocharger air pressure (At less than Notch 8, FULL LOAD)	Possibly, no fault. Turbocharger air pressure is not indicated until in Notch 6, and above, and under load. There is no indication when in dynamic braking.		

INSPECTION

GENERAL

When mounted in the locomotive, the turbocharger is a difficult piece of equipment to check quickly and qualify for continued service. The turbocharger is frequently judged to be faulty on the basis of operating-crew reports or on the basis of symptoms noted while the locomotive is being operated during the inspection process. While the symptom noted may identify a defective turbocharger, it has frequently happened that the same symptom applies to other faults on a locomotive, so many turbochargers are replaced unnecessarily. Refer to Table I for examples of symptoms showing multiple faults.

INSPECTION ON LOCOMOTIVE

The preferred method of qualifying a turbocharger for continued service is to observe it (and its effects) while

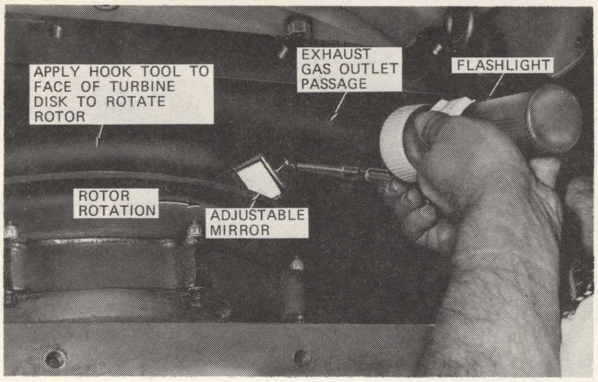
APPLY HOOK TOOL TO FACE OF TURBINE DISK TO ROTATE ROTOR
EXHAUST GAS OUTLET PASSAGE
FLASHLIGHT
ROTOR ROTATION
ADJUSTABLE MIRROR

FIG. 9. INSPECTING TURBINE-BUCKET BLADES.

load-testing the locomotive. Load-testing should only be performed after first establishing the following items are functioning and correct:

1. Fuel pump racks – correctly set and equal
2. Fuel pumps – properly timed
3. Fuel-injection pumps and nozzles – all must function
4. Air-intake and exhaust manifolds – free of leakage
5. Valve tappet clearance – correctly set
6. Fuel filter and engine air filters – cannot be plugged
7. Fuel linkage – free moving
8. Excitation circuits – must be in good order and capable of being adjusted.

When under FULL LOAD and in Notch 8, observe turbocharger air pressure, color of exhaust gases, governor load pot action, and check the turbocharger for oil and water leakage and mechanical distress. Use Table I to identify a faulty turbocharger or other locomotive component.

When it is not possible to load-test the locomotive, perform the following turbocharger check, with the locomotive shut down:

1. Working down thru the stack, use a flashlight and a mirror positioned to observe the turbine-disk blades. See Fig. 9. While observing the blades, use a hook tool, made from 1/8-in. diameter stainless steel, to lift and rotate rotor thru one complete revolution. Examine all blades for possible damage caused by foreign material, and check rotor for free rotation. Performing this operation will often break up carbon build-up (which causes reduced rotor speed) and allow continued use of the turbocharger.

2. Remove the clamps, flexible duct, and air duct from the compressor end of the turbocharger. See Fig. 12.

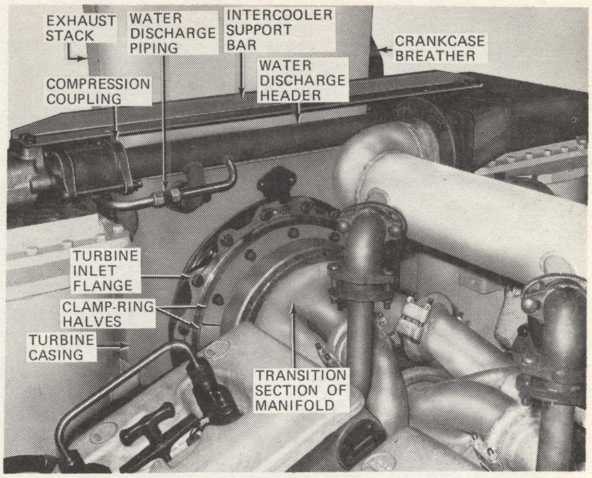
EXHAUST STACK
WATER DISCHARGE PIPING
INTERCOOLER SUPPORT BAR
CRANKCASE BREATHER
COMPRESSION COUPLING
WATER DISCHARGE HEADER
TURBINE INLET FLANGE
CLAMP-RING HALVES
TURBINE CASING
TRANSITION SECTION OF MANIFOLD

FIG. 10. TURBO INSTALLATION DETAILS — TURBINE END, WITH SINGLE-PIPE EXHAUST MANIFOLD.

   Manually turn the rotor, and note that rotor is free to rotate. Set up a dial indicator and move the rotor, as required, to check the axial and radial clearance. Refer to DATA section for limits.

3. Check for plugged seal-air passages. Disconnect the seal-air pipes and apply shop air into the seal-air passages in the turbine casing. If passages are clear, the sound of escaping air will be heard at the stack outlet. This operation can often clear a partially-blocked passage.

4. Check visually for evidence of mechanical damage, excessive heat and water leaks.

REMOVING TURBOCHARGER

At intervals stated in Inspection and Maintenance Instruction, or when inspection establishes a turbocharger is faulty, remove the turbocharger in the following manner:

1. Drain the locomotive cooling water system.

2. Remove the hatch over the turbocharger.

3. Disconnect the crankcase breather from the exhaust stack (Fig. 11). If so equipped, remove the four aspirator hoses (Fig. 12). Remove the exhaust stack from the turbocharger turbine casing.

4. Remove the intercooler support bar (Fig. 10).

5. Remove the two compression couplings from the water discharge header (Fig. 10).

6. Disconnect the exhaust manifold from the turbine inlet assembly by removing the bolts and heat-treated washers, then the clamp-ring halves (Fig. 10).

FIG. 9, E-23320
FIG. 10, E-24458

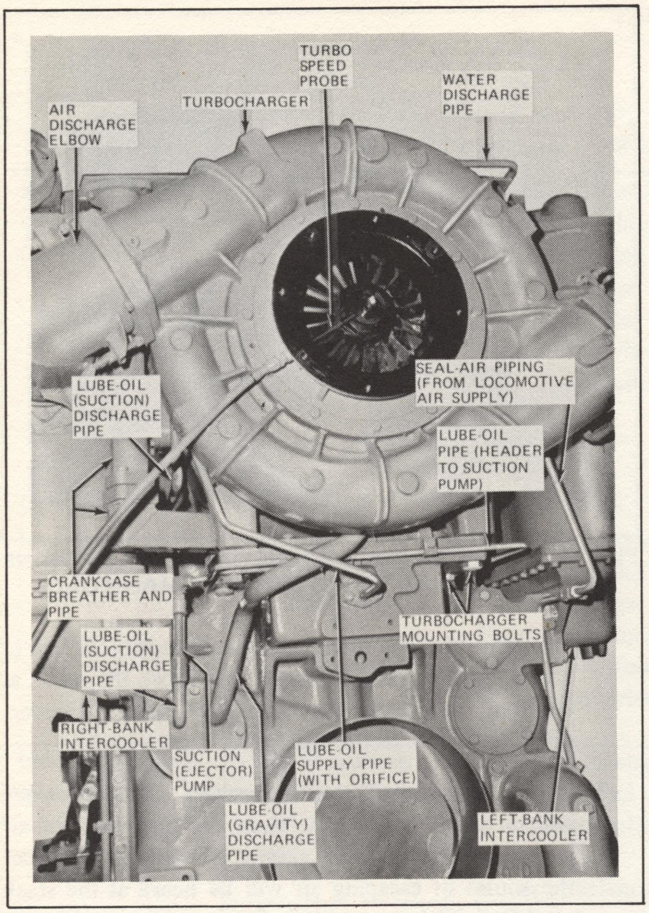
TURBO SPEED PROBE
TURBOCHARGER
WATER DISCHARGE PIPE
AIR DISCHARGE ELBOW
SEAL-AIR PIPING (FROM LOCOMOTIVE AIR SUPPLY)
LUBE-OIL (SUCTION) DISCHARGE PIPE
LUBE-OIL PIPE (HEADER TO SUCTION PUMP)
CRANKCASE BREATHER AND PIPE
TURBOCHARGER MOUNTING BOLTS
LUBE-OIL (SUCTION) DISCHARGE PIPE
RIGHT-BANK INTERCOOLER
SUCTION (EJECTOR) PUMP
LUBE-OIL SUPPLY PIPE (WITH ORIFICE)
LUBE-OIL (GRAVITY) DISCHARGE PIPE
LEFT-BANK INTERCOOLER

FIG. 11. TURBO INSTALLATION DETAILS, COMPRESSOR END.

FIG. 11, E-24459

7. If so equipped, disconnect the turbine-casing rain drain. Remove all fittings, pipes, clamps, etc. and retain for application on the replacement turbocharger.

8. Remove the two air-discharge elbows (Fig. 11).

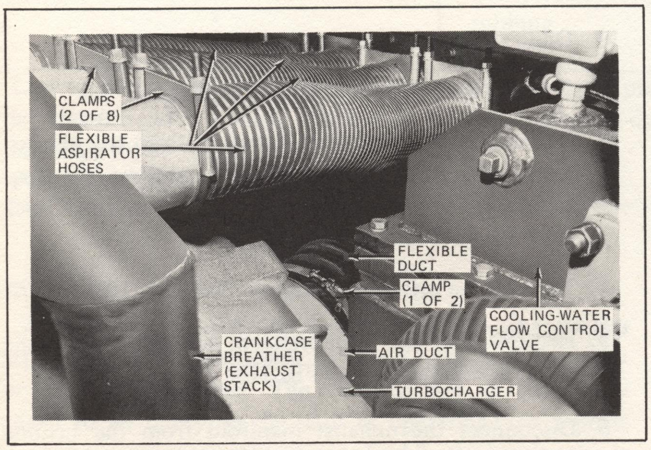
CLAMPS (2 OF 8)
FLEXIBLE ASPIRATOR HOSES
FLEXIBLE DUCT
CLAMP (1 OF 2)
COOLING-WATER FLOW CONTROL VALVE
CRANKCASE BREATHER (EXHAUST STACK)
AIR DUCT
TURBOCHARGER

FIG. 12. TURBO INSTALLATION DETAILS, COMPRESSOR END.

FIG. 12, E-24460

9. Remove clamps, flexible duct, and metal air duct (Fig. 12) from the compressor end of the turbocharger.

10. If so equipped, disconnect the CHEC-excitation speed pick-up probe at the terminal box.

11. Refer to Fig. 11. Disconnect and remove the external lube-oil piping in the following order:

    a. Lube-oil supply pipe, with orifice, at the forward-end cover and the turbine casing.

    b. Lube-oil suction discharge pipe at the suction pump and the turbine casing.

    c. Lube-oil pipe at the suction pump and the forward-end cover.

    d. Lube-oil discharge pipe at the turbine casing.

    e. The cover-discharge pipe together with the suction pump from the forward-end cover.

12. Disconnect the seal-air piping (from locomotive air supply) at the turbine casing.

13. Remove the four mounting bolts and lockwashers (Fig. 11) which secure the turbocharger to the forward-end cover.

14. Use lifter, Part 147X1916-1, to remove turbocharger from engine. Slightly rock the turbocharger, as it is lifted, to free the two rear feet from their locating dowels.

CAUTION: *Exercise care in removing the turbocharger so as not to damage the exhaust manifold.*

15. After positioning the turbocharger on the floor:

    a. Remove the water discharge header and retain for application on the replacement turbocharger.

    b. Remove the CHEC-excitation speed pick-up probe from the blower inlet and retain for application on the replacement turbocharger.

    c. If the turbocharger was removed because of a failure (and not for a periodic replacement), thoroughly examine the turbocharger and DETERMINE THE CAUSE OF FAILURE. Failure to do so will probably result in a repeat failure. If failure was caused by foreign material, it is MANDATORY that all traces of this material be removed from the system; that is, it may be necessary to remove and clean the exhaust manifold, or it might be necessary to remove the air filters and clean and inspect the filter clean-air plenum. Also inspect the inlet side of both intercoolers for foreign material.

d. Apply protective covers and pipe plugs to all openings in the removed turbocharger. Apply new covers and plugs or remove from the replacement turbocharger.

e. Remove the crankcase breather cover and clean the screen assembly. Refer to Lubricating-Oil System Instructions under Tab DE-13.

CAUTION: *If turbocharger is being replaced because of bearing failure, check the cavity in the top of the forward-end cover when the screen assembly is removed; make certain the pipe-tapped hole is fitted with a pipe plug. Failure to plug this hole will result in a loss of lube-oil supply to the turbocharger bearings.*

INSTALLING TURBOCHARGER

If turbocharger is being installed as a result of a failure (and not for a periodic replacement), correct the cause of the failure. Apply new gaskets and lockwashers and install turbocharger in the following manner:

1. From the replacement turbocharger, remove all protective covers and the pipe plugs from the lube-oil and seal-air inlets and (if so equipped) the rain-drain outlet. Make certain no foreign material is in the turbocharger.

2. Pour some clean engine lube-oil into the oil inlet near the top of the turbine casing, and rotate the rotor assembly several revolutions.

3. Using new gaskets, assemble the water discharge header (Fig. 10) to the turbine casing.

4. If so equipped, install the CHEC-excitation speed pick-up probe. Check gap between end of probe and outside diameter of rotor cap, which must be 0.028-0.090 in. (0,711-2,286 mm). See Fig. 13.

CAUTION: *If speed pick-up probe is not used, apply a suitable cover plate, Part 126X1545, over the probe hole. Otherwise, harmful dirt will be pulled into the turbo thru the probe hole and delivered into the engine.*

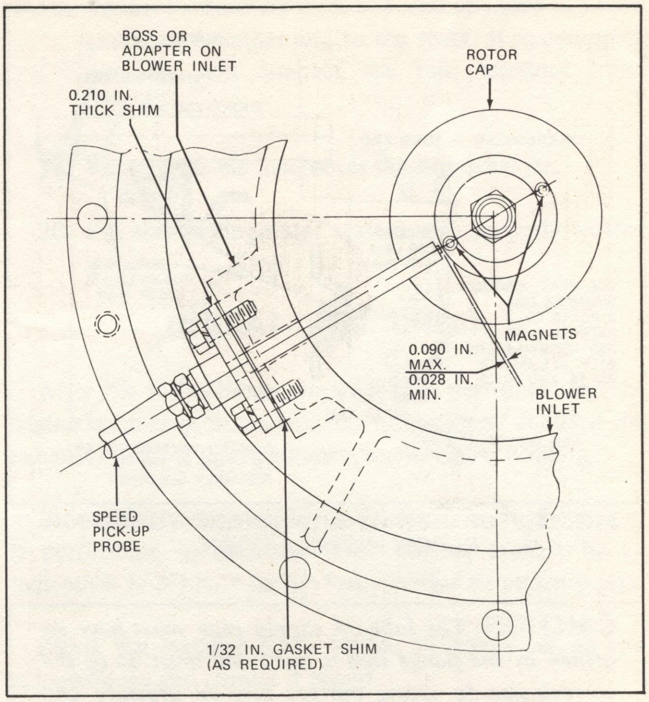

FIG. 13. AIR INLET VIEW OF TURBOCHARGER.

FIG. 13, E-24527

5. Clean the mounting surface of the forward-end cover and deburr the locating dowels, if required. Apply a light film of grease to the two dowels, and install two new O-rings around the water supply openings.

6. Using lifter, Part 147X1916-1, hoist and raise the turbocharger. Clean and deburr (if required) the four mounting feet. Position the turbocharger to align the two dowel holes in the rear feet with the locating dowels. Slightly rock the turbocharger while lowering it onto the forward-end cover.

CAUTION: *Exercise care while installing the turbocharger to avoid damaging the exhaust manifold.*

7. Using new lockwashers, assemble the four mounting bolts. Using mounting bolt wrench set, Part 147X1952, tighten bolts with a torque of 150-165 lb.-ft. (203-224 N·m).

NOTE: *When using mounting bolt wrench set, Part 147X1952, apply 93-103 lb.-ft. (126-140 N·m) of torque (as indicated on the torque wrench) to achieve the 150-165 lb.-ft. (203-224 N·m) of torque required on the mounting bolts.*

8. Wash and blow out all lube-oil piping, then refer to Fig. 11 and assemble them in the reverse order used at removal. Refer to Step 11 under REMOVING TURBOCHARGER section.

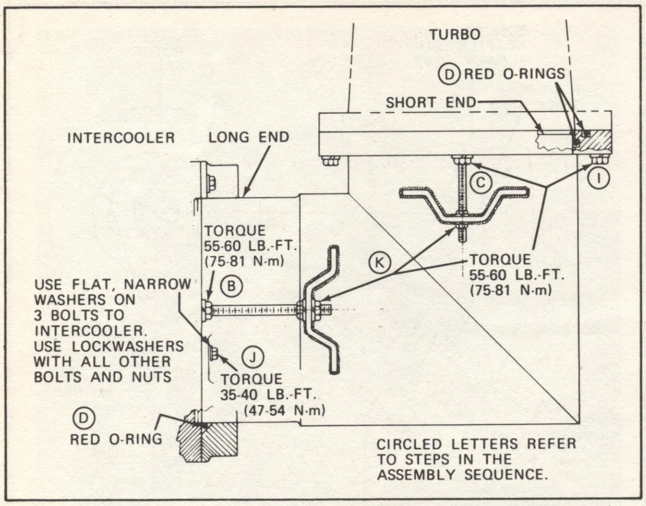
TURBO
Ⓓ RED O-RINGS
SHORT END
INTERCOOLER
LONG END
Ⓒ
Ⓘ
TORQUE
55-60 LB.-FT.
(75-81 N·m)
Ⓑ
USE FLAT, NARROW WASHERS ON 3 BOLTS TO INTERCOOLER. USE LOCKWASHERS WITH ALL OTHER BOLTS AND NUTS
Ⓚ
TORQUE
55-60 LB.-FT.
(75-81 N·m)
Ⓙ
TORQUE
35-40 LB.-FT.
(47-54 N·m)
Ⓓ
RED O-RING
CIRCLED LETTERS REFER TO STEPS IN THE ASSEMBLY SEQUENCE.

FIG. 14. TOP VIEW OF RIGHT-HAND TURBO AIR ELBOW INSTALLATION.

FIG. 14, E-23340A

CAUTION: *The lube-oil supply pipe must have an orifice in the flange that is open and must be of the correct size to assure correct lube-oil pressure and flow to the turbocharger bearings. Orifice diameter must be 0.352-0.348 in. (8,89-8,84 mm).*

9. Connect the seal-air piping (from locomotive air supply) to the turbine casing.

10. If used, connect the CHEC-excitation speed pick-up probe at the terminal box.

11. Assemble the metal air duct to the compressor end of the turbocharger. Assemble the flexible duct and secure with two clamps (Fig. 12).

12. Assemble the two air-discharge elbows between the turbocharger and the intercoolers in the following manner:

A. Inspect the elbows and flanges. Pay particular attention to the four lugs on each elbow. Make sure they are all present, square, and the welds holding them to the elbow are not cracked. Replace or repair any elbows that have defective lugs or fewer than the required four. Check O-ring seats for wear. Don't use the elbow if those seats are worn appreciably. Leaks will result.

B. Install the two studs in each intercooler, using lockwashers under the nuts. Torque the nuts to 55-60 lb.-ft. (75-81 N·m). Apply an extra nut and lockwasher on each stud. Run the nut up near to the stud-locking nut, with the lockwasher on the outside, ready to bear against the elbow lug.

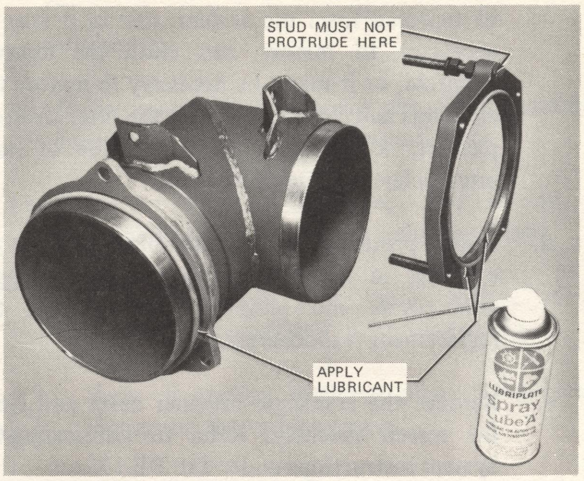
STUD MUST NOT PROTRUDE HERE
APPLY LUBRICANT
LUBRIPLATE
Spray
Lube'A'

FIG. 15. ELBOW PARTIALLY PRE-ASSEMBLED.

FIG. 15, E-23341

C. Screw two more studs into each of the turbo-end bolting flanges. Do not thread studs through the flanges. If this is done, it will be impossible to make a tight seal between flange and turbocharger. Use lockwashers under the nuts and torque to 55-60 lb.-ft. (75-81 N·m). Again, apply an extra nut and lockwasher on each stud, positioning them as was done on the intercoolers.

D. Preassemble the two elbows and flanges, using new red O-rings, Part 115X1902. Do not use Part 115X1268 black O-ring ahead of the intercooler. It will not withstand the higher air temperature. Before applying the O-rings, lubricate with Lubriplate Spray Lube "A"*, Part 147X1614. This reduces the probability of O-ring damage during installation.

E. Slide the turbo-end flange (with O-rings) onto the elbow. Take care not to disturb the O-ring in the flange groove. Make certain the studs enter the holes in the lugs. Loosely apply lockwashers and nuts to the outer end of the studs.

F. Apply the elbow, with preassembled flanges and O-rings, to the engine. The shorter end goes into the turbo; the longer one into the intercooler. Position elbow so each end enters its hole squarely.

G. Finger-tighten the four bolts (with lockwashers) attaching the turbo-end flange.

H. Then slide the flange and O-ring into position against the intercooler. Install and finger-tighten the three bolts with flat, narrow washers in that flange.

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*Product of Fiske Bros. Refining Co.

I. Again, check to make certain the elbow is squarely positioned and all four studs are through their respective lugs. Then, tighten the four bolts on the turbo-end flange evenly, in a criss-cross pattern, to 55-60 lb.-ft. (75-81 N·m).

J. Torque the three bolts on the intercooler flange evenly to 35-40 lb.-ft. (47-54 N·m).

K. Run the inside nuts and lockwashers on the studs up against the lugs until they touch plus 1-1/2 to 2 turns. Then, torque the outside nuts to 55-60 lb.-ft. (75-81 N·m). Use two wrenches simultaneously, if necessary, to keep the studs from turning. Do not bend or distort the lugs during this operation.

13. If so equipped, assemble and connect the turbine-casing rain drain.

14. Connect the exhaust manifold to the turbine inlet assembly as follows:

   a. Make sure all manifold-to-turbocharger bolt threads are clean. If necessary, wire-brush all bolt threads and retap all threaded holes. Apply high-temperature anti-seize thread compound, Part 147X1640, to all threads of bolts and tapped holes and to the washer face of bolt heads.

   b. With a new gasket installed in the groove in the turbine inlet flange, assemble the lower clamp ring half and secure with bolts and new lockwashers finger-tight. The joint line of the clamp ring should be near horizontal.

   c. Assemble the top clamp ring half and secure with bolts and new lockwashers. After equalizing the gaps at the joint line, alternately tighten all bolts up to the final torque of 70-75 lb.-ft. (95-102 N·m).

15. Using new gaskets, assemble the two compression couplings to the water discharge header (Fig. 10).

16. Assemble the intercooler support bar (Fig. 10).

17. Install the stack and secure with bolts and lockwashers. Torque bolts to 55-60 lb.-ft. (75-81 N·m).

18. Connect the crankcase breather pipe to the crankcase breather and to the stack. If so equipped, assemble and connect the four aspirator hoses (Fig. 12).

19. Reassemble the hatch over the turbocharger.

20. Fill the cooling-water system with properly treated water.

OPERATIONAL CHECK

After the turbocharger work has been performed and the engine is running, listen near the turbocharger and near the exhaust stack for unusual noises, such as parts rubbing.

If possible, load the engine and observe that turbocharger is performing its function. This will be evident by an indication of pressure on the turbocharger air pressure gage.

Check the installed turbocharger for water, oil, air and exhaust leaks and correct if found.

DATA

	English	Metric
Weight, turbocharger	1470 lb.	667 kg
Rotor, end-play:		
New	0.013- 0.021 in.	0,330- 0,533 mm
Max. worn	0.025 in.	0,635 mm
Rotor, diametral clearance in bearings:		
New	0.003- 0.0055 in.	0,076- 0,140 mm
Max. worn	0.0065 in.	0,165 mm
Speed pick-up probe to cap, clearance	0.028- 0.090 in.	0,711- 2,286 mm

TORQUE VALUES

	Lb.-Ft.	N·m
Bolts, turbocharger mounting	150-165	203-224
Bolts, stack clamping	55-60	75-81
Bolts, exhaust manifold to turbocharger	70-75	95-102
Nuts, stud-locking and ear-clamping, air-discharge elbows	55-60	75-81
Bolts, flange to intercooler	35-40	47-54